Modular Classification and Change Analysis of Vegetation Encroachment using Object-based Image Analysis

S. Günther, E. Krätzschmar, J. Sehner, H. Klemm (IABG mbH Dresden/Munich, Germany)
A. Böhm (US ARMY, USAG Hohenfels, Germany)
J.R. Phillips (PARSONS, Richmond, USA)

ICC Dresden, 28.08.2013
IABG Geodata Factory – Geodata Services

**Interpretation / Digitizing**
- Vector data mapping
- Automated Image analysis
- Classification & attribution
- Analysis of aerial & space borne imagery
- Topographic maps / plots

**Data acquisition**
- Flight campaigns
- Aerial & space borne imagery
- Digital terrain & surface models
- Laser scanning data (LIDAR)
- Vector & attribute data, map research

**3D Stereo Analysis**
- 3D city models
- Splitted waste water charge
- Analysis of solar potential
- Cadastral register for roads & open space

**Photogrammetry**
- Terrain models – DTM
- Surface models – DSM
- Aerial triangulation & orthophoto production
- Orthophoto mosaicing

**Geoinformatics**
- GIS development
- Add-Ins, user interfaces, web
- Modeling of (geo-) databases
- Database connection to GIS/CAD systems
- Interface programming

**GIS-Consulting**
- Project management
- Consulting for GIS-Systems
- GIS & Migration
- Quality assurance
Content

- Study Area and Motivation
- Data
- Classification Technology „on three pillars“
- Classification Results
- Quality Assurance
- Summary
Study Area

- Hohenfels, Germany
- Military training area under use (~ 160 km²)
- Karst/ limestone soils and semi-natural grasslands and pastures
- Biodiversity in the need of ecological protection
- Endangered by spread of invasive plants/ scrub encroachment - including Blackthorn (*Prunus spinosa*)
Situation in the Study Area
Background – Why Remote Sensing?

- Area under focus (excluding forest) ~ 58 km²
- Reduction costs:

<table>
<thead>
<tr>
<th>Status</th>
<th>Description</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low Status</td>
<td>Grazing animals &amp; mowing</td>
<td>ca. 200€/ha*</td>
</tr>
<tr>
<td>Medium Status</td>
<td>Mowing, mulching, renaturation</td>
<td>400 – 5000 €/ha*</td>
</tr>
<tr>
<td>High Status</td>
<td>Mulching, manual internshop renaturation</td>
<td>3000 – 8000€/ha*</td>
</tr>
</tbody>
</table>

- Early action is much more cost effective
- Control measures are necessary for reduction of encroachment
- Efficient instrument to map the entire area

Data

Aerial Imagery 2007

LiDAR Optech ALTM 3100
DSM/DTM 2007

WorldView-2 2012

LiDAR Trimble Harrier 56
DSM/DTM 2012

Reference mappings
Classification Technology – Spectral Pillar

Spectral Signatures
Aerial img./ WorldView-2
Classification Technology – Spectral Analysis

Grassland

Blackthorn (young)

Forest

Blackthorn
Classification Technology – Height Pillar

Spectral Signatures
Aerial img./ WorldView-2

Exclusion criteria

LiDAR
height differences
Classification Technology – LiDAR Data

2007/03/15 (Optech ALTM 3100 (1m))

2012/03/23 Trimble Harrier 56 (0.5m)

situation

DSM 2007
Optech ALTM 3100 (1m)

DSM 2012
Trimble Harrier 56 (0.5m)

DTM

(DSM-DTM)
Classification Technology – LiDAR Data

- Object-based Image Analysis
- Rule set technology
- Using contextual information (neighbourhood), relations and changes
Classification Technology – Texture Pillar

- Texture
  WorldView-2 pan

- Spectral Signatures
  Aerial img./ WorldView-2

- LiDAR
  height differences

- Variance,
  Neighbourhood relationship

Exclusion criteria
Classification Technology – Texture Analysis

- Homogeneous texture, no elevation
- Texture, no elevation (shadow)
- Texture, no elevation (vegetation)
- Texture, elevation (forest-shrub)
Classification Technology – Feature Space

Texture
WorldView-2 pan

LiDAR
height differences

Spectral
Aerial img.

Variance,
Neighbourhood relations

transitional bands

Combination
Classification Technology – Feature Space

Object-based Image Analysis

- Logic expansion of classification via
  - Reference knowledge
  - Neighbourhood relationships
  - Plausibilities & Valuing of changes 2007/2012
  - Minimum values / Similarities

Texture WorldView-2 pan

Spectral Signatures Aerial img./ WorldView-2

Exclusion criteria

LiDAR height differences

Variance, Neighbourhood relations

defined Class

Combination

low shrub

mixed growth

young, closed
Classification Result – Status and Change Analysis

Comparison of data from 2007 and 2012, showing changes in land use.

<table>
<thead>
<tr>
<th>2007</th>
<th>2012</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>flat</strong></td>
<td><strong>medium</strong></td>
</tr>
<tr>
<td>grassland, open</td>
<td>new Shrub</td>
</tr>
<tr>
<td>LIDAR effect mulched area</td>
<td>Shrub</td>
</tr>
<tr>
<td>LIDAR effect/resolution clearing</td>
<td>LIDAR effect Shrub</td>
</tr>
</tbody>
</table>
Classification Result

LIDAR height differences
Spectral signature aerial img./WorldView-2
Texture
+ eCognition (rule set)

<table>
<thead>
<tr>
<th>aggregated classification</th>
</tr>
</thead>
<tbody>
<tr>
<td>secure classes:</td>
</tr>
<tr>
<td>class.matrix</td>
</tr>
<tr>
<td>Generalisation1:</td>
</tr>
<tr>
<td>Similarity,</td>
</tr>
<tr>
<td>Neighborhood,</td>
</tr>
<tr>
<td>Size/ location</td>
</tr>
<tr>
<td>Generalisation2:</td>
</tr>
<tr>
<td>Class!, rel. difference,</td>
</tr>
<tr>
<td>location/ plausibility</td>
</tr>
</tbody>
</table>

Mask (Change elements)
Quality Assurance – Field Check

- Visual control with result and experts: complete matching
 Numeric control with reference data - “Monitoring of Vegetation Control Areas” (NRI) using 84 2x2m plots: correlation of 94%
Summary

- Control measures for scrub encroachment are essential for military training areas in order to
  - Protect heterogeneous habitats (heterogeneous grassland, etc.) and
  - Enable training activities

- Object-based image analysis and modular classification technology allow high quality status mapping and change analysis

- LiDAR (surface and terrain) in combination with spectral information (WorldView-2 or other) enables a high degree of accuracy

Thank you for your attention!
IABG Geodata Factory – Geodata Services

**Interpretation / Digitizing**
- Vector data mapping
- Automated Image analysis
- Classification & attribution
- Analysis of aerial & space borne imagery
- Topographic maps / plots

**Data acquisition**
- Flight campaigns
- Aerial & space borne imagery
- Digital terrain & surface models
- Laser scanning data (LIDAR)
- Vector & attribute data, map research

**3D Stereo Analysis**
- 3D city models
- Splitted waste water charge
- Analysis of solar potential
- Cadastral register for roads & open space

**Photogrammetry**
- Terrain models – DTM
- Surface models – DSM
- Aerial triangulation & orthophoto production
- Orthophoto mosaicing

**Geoinformatics**
- GIS development
- Add-Ins, user interfaces, web
- Modeling of (geo-) databases
- Database connection to GIS/CAD systems
- Interface programming

**Contact**
IABG mbH Geodata Factory
Sylvia Günther
Herrmann-Reichelt-Str. 3
01109 Dresden
+49 351 8923-144
guentthers@iabg.de
www.iabg.de